AFFINE-BASED TIME-SCALE ULTRA WIDEBAND WIRELESS CHANNEL SIMULATOR FOR TIME-VARYING COMMUNICATION ENVIRONMENT

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To my beloved supervisors, families and friends

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ABSTRACT

Wireless communication systems require reliable wireless link to provide high quality services for all subscribers around the world. This can be ensured by using a combination of different techniques and technologies whose performance depend on wireless channel. Therefore, an appropriate channel model based on affine approach needs to be developed to describe its performance, availability, and wide range assessments in term of Ultra Wideband (UWB) propagation characteristics. In order to develop a future communication system, knowing the channel behaviour is important to seamlessly integrate many different communication systems and enhance services to users. In a typical laboratory environment, knowledge of channel behaviour is obtained from channel simulators which are designed to mimic the physical channel. The Fourier-based channel eigenstructure employed in designing most conventional simulators and their applications for UWB channels are limited due to wider bandwidth. Therefore, by considering affine-based time-scale operator, a discrete channel model is developed. The UWB channel simulator is developed based on affine time-scale channel model. The model and simulator are developed by using LabVIEW® software platform. Then, the developed UWB simulator is implemented on Field-Programmable Gate Array (FPGA) hardware platform. This UWB channel simulator is designed for short distance, at range (0-30m) with the frequency range at (3.1-5.3GHz). This simulator is also be simulated for different channel parameters such as different operating environment for indoor and/or outdoor to observe its performance. The channel effect toward signals is obtained by analyzing the simulation and the measurement results of the root means square (RMS) delay spread. The received signal, power delay profile and RMS delay spread are presented to evaluate the UWB channel simulator performance. The RMS delay spread for non line-of-sight (NLOS) is obtained around 1.8843ns and LOS is around 1.6894ns. It shows that RMS delay spread for NLOS is high than the LOS. The maximum RMS delay spread for indoor and outdoor environments are 4ns and 7ns, respectively. The difference in the RMS delay spreads describes different propagation phenomenon operating environment. In addition, these numerical values indicate the UWB channel simulator performance for small-scale fading. Affine shows a flexible approach in analyzing the non-stationary environment compared to Fourier analysis and Fourier analysis needs to count every frequency change and may increase system complexity. The results are validated based on measurement and comparison from previous work. Finally, the UWB channel simulator has been implemented into FPGA device as a UWB channel simulator-hardware platform.

ABSTRAK

Sistem komunikasi tanpa wayar memerlukan kebolehan pautan tanpa wayar untuk menyediakan kualiti perkhidmatan yang tinggi terhadap semua pelanggan di seluruh dunia. Ini dapat dicapai dengan menggunakan gabungan teknik dan teknologi yang berbeza di mana prestasinya bergantung kepada saluran tanpa wayar. Oleh itu, model saluran yang sesuai diperlukan seperti memiliki kadar data yang tinggi, kebolehsediaan dan penilaian pelbagai. Dalam usaha membangunkan satu sistem komunikasi masa depan, mengetahui tingkah laku saluran membolehkan kita untuk mengintegrasikan dengan lancar, menyediakan perkhidmatan sistem komunikasi yang berbeza dan meningkatkan perkhidmatan kepada pengguna. Dalam persekitaran makmal, pemerolehan pengetahuan tentang saluran diperolehi daripada penyelaku saluran yang direka berdasarkan fizikal saluran yang dikehendaki. Disebabkan batasan saluran struktur eigen Fourier yang telah digunakan dalam reka bentuk penyelaku secara konvensional adalah terhad dan penggunaan untuk saluran jalur lebar juga terhad. Berdasarkan pengendali skala masa afin saluran diskret direka, saluran ini direka untuk penggunaan penyelaku saluran jalur lebar dan juga boleh digunakan untuk saluran radio yang lain, sama ada jalur lebar atau jalur sempit. Semua program dan simulasi yang dibangunkan dalam perisian LabVIEW®. Penyelaku direka dan kemudiannya dilaksanakan pada binaan perkakasan tata susunan get boleh aturcara medan. Kesan saluran ke atas isyarat diperolehi dengan menganalisis simulasi dan keputusan pengukuran parameter saluran. Saluran ini direka bentuk bagi jarak pengukuran yang pendek sekitar (0-30m) dengan frekuensi (3.1-5.3GHz). Saluran ini juga dianalisis dalam persekitaran yang berbeza iaitu persekitaran luar dan persekiran dalam. Kesan saluran dikenalpasti dengan menganalisis keputusan rebakan lengah punca min kuasa dua daripada simulasi dan pengukuran. Isyarat yang diterima, profil kelewatan kuasa dan rebakan lengah punca min kuasa dua yang diperolehi menentukan keberkesanan saluran jalur lebar itu. Rebakan lengah punca min kuasa dua untuk bukan garis nampak adalah 1.8843ns dan garis nampak sebanyak 1.6894ns. Rebakan lengah punca min kuasa dua ini menunjukkan bahawa bukan garis nampak adalah lebih tinggi berbanding garis nampak. Manakala rebakan lengah punca min kuasa dua yang maksimum untuk persekitaran dalam dan luar masing-masing adalah 4ns dan 7ns. Rebakan lengah punca min kuasa dua yang berbeza menunjukkan fenomena persekitaran yang berbeza. Selain itu, nilai-nilai yang diperolehi daripada penyelakuan ini menunjukkan bahawa saluran jalur lebar dikategorikan sebagai saluran skala kecil. Afin menunjukkan bahawa saluran yang direka adalah sangat fleksibel di mana dapat digunakan dalam pelbagai persekitaran dan fenomena cuaca berbanding Fourier. Berdasarkan Fourier setiap frekuensi yang berubah disebabkan persekitaran hendaklah dikira mengikut perubahan nilai frekuensi dan menyebabkan rekaan saluran menjadi lebih rumit. Keputusan saluran ini disahkan dan dibandingkan dengan pengukuran dan perbandingan dengan keputusan penyelidikan yang lepas. Akhirnya, rekaan penyelaku saluran ini di pindahkan ke dalam bentuk perkakasan yang dikenali sebagai tata susunan get boleh aturcara medan penyelaku saluran.